

A Natural Interaction Interface for UAVs Using Intuitive Gesture Recognition

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Outline

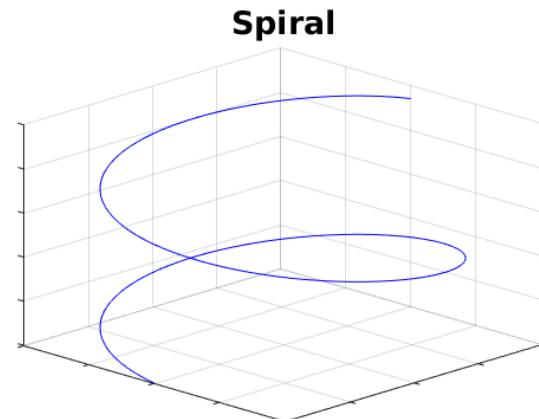
1. Objectives
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3. Gesture Sensor
 - Leap Motion
4. Ground Control System
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 - Gesture Module
 - Trajectory Generation
 - Validation
5. Demo Video
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Objectives

Develop a gesture-based natural language interface which non-expert users can quickly and easily use to build a desired flight path for an autonomous UAV by defining trajectory segments.

System Considerations:

1. Intuitive natural interaction
 - Similar to speaking with another person
2. Simple interface flow
3. Ample feedback for decision making
4. User concerned only with high-level mission definition

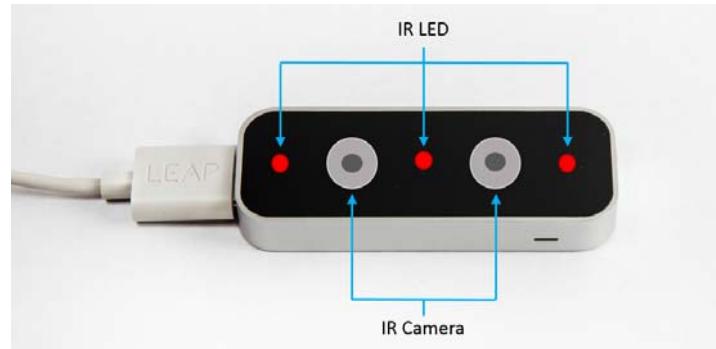




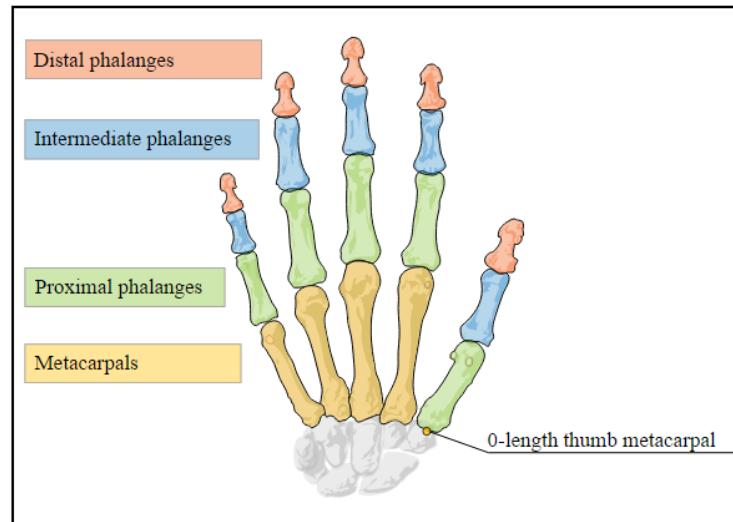
Mission Parameters

- Fly multiple vehicles
- Correlative data acquisition
- Intuitive interface
- DO NOT need low-level understanding of architecture

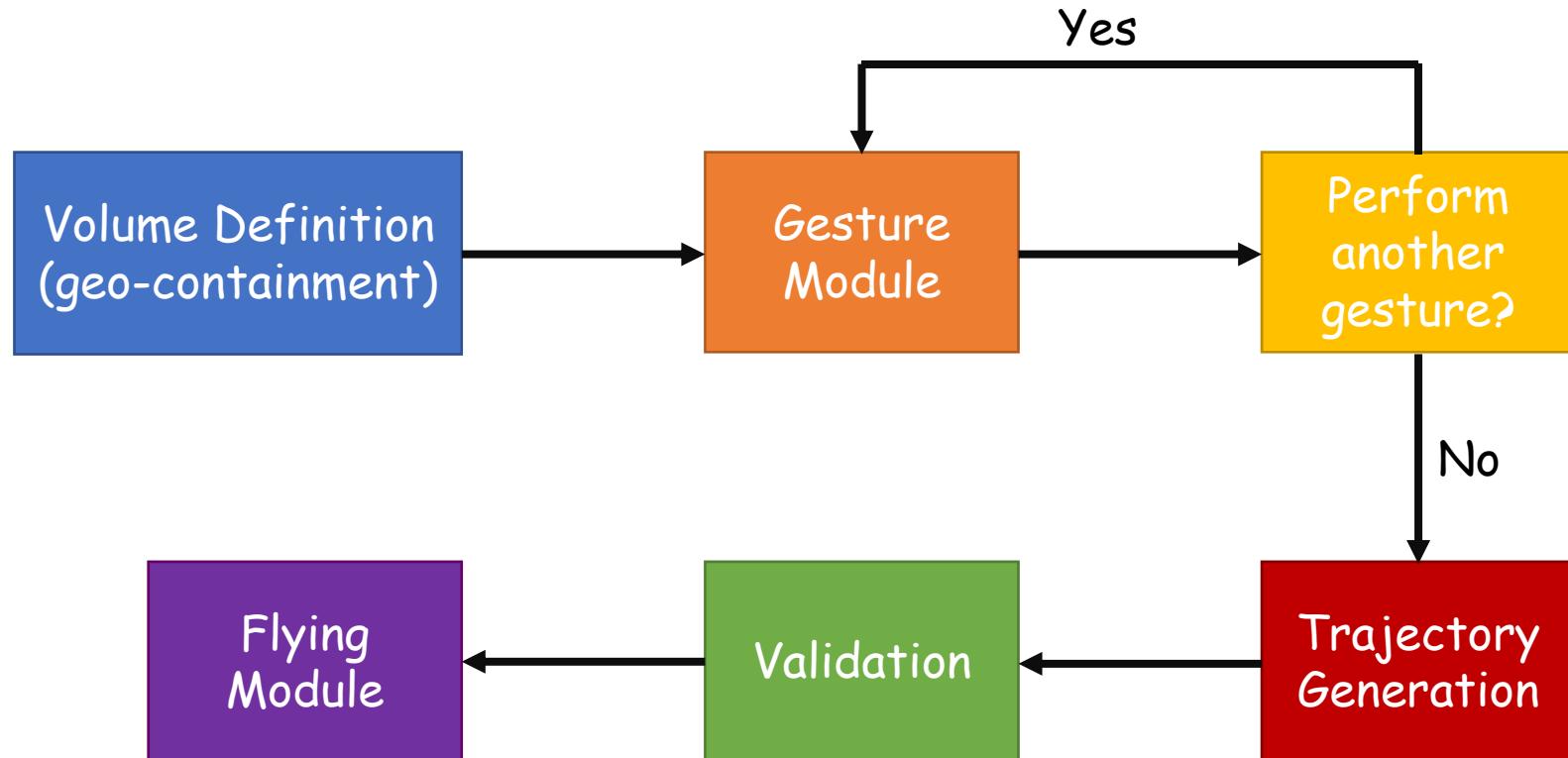
Leap Motion Controller

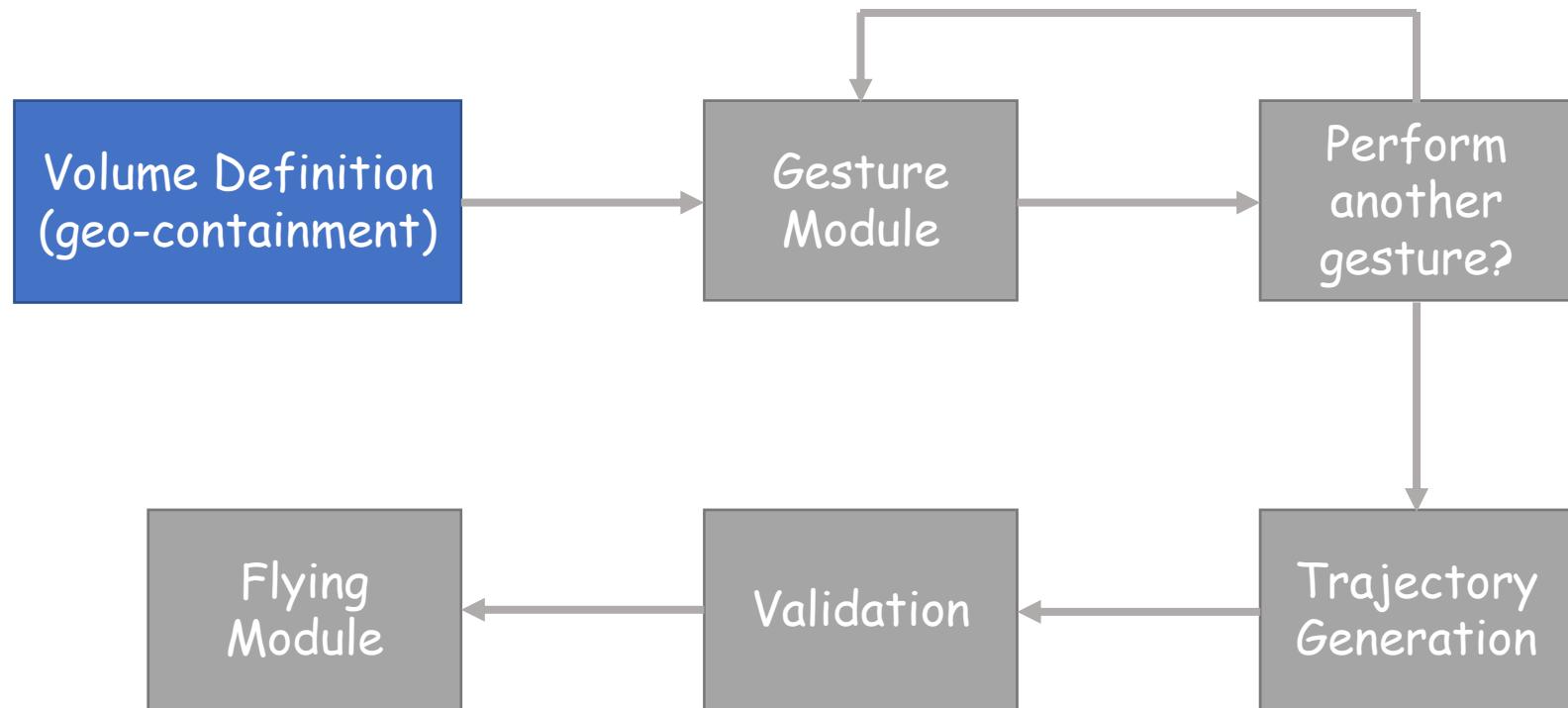


- Infrared cameras
- 200 frames per second
- 150° field of view
- 8 ft³ of interactive space

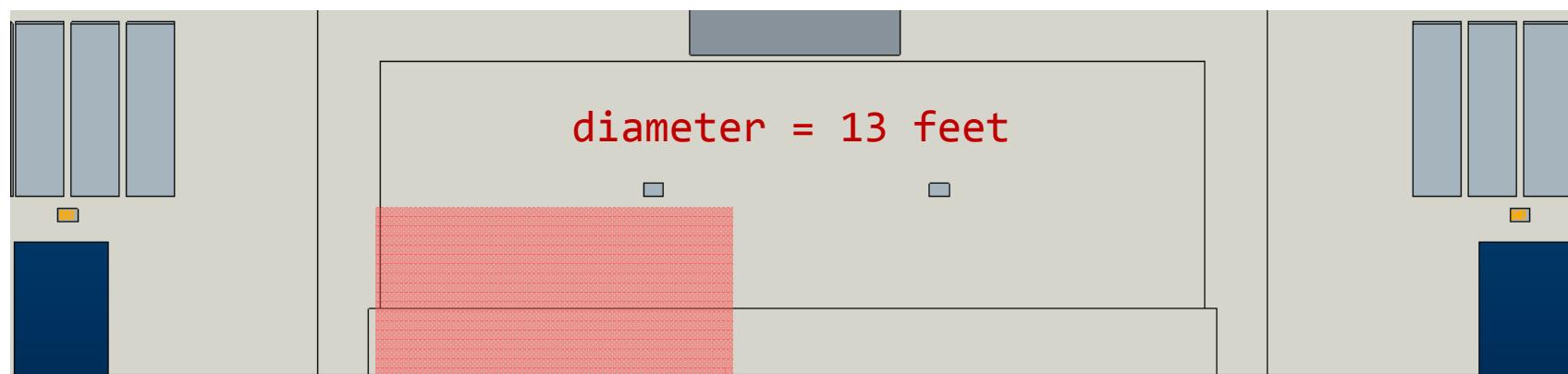
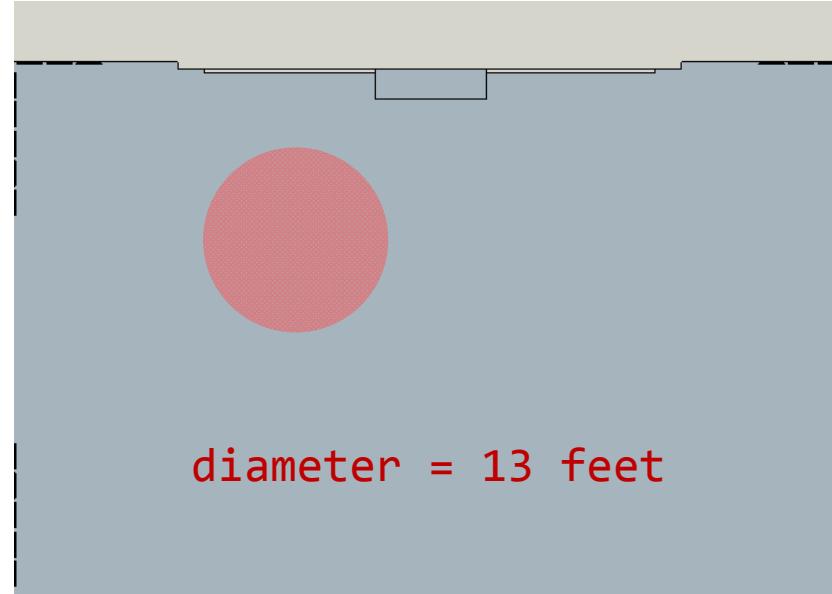


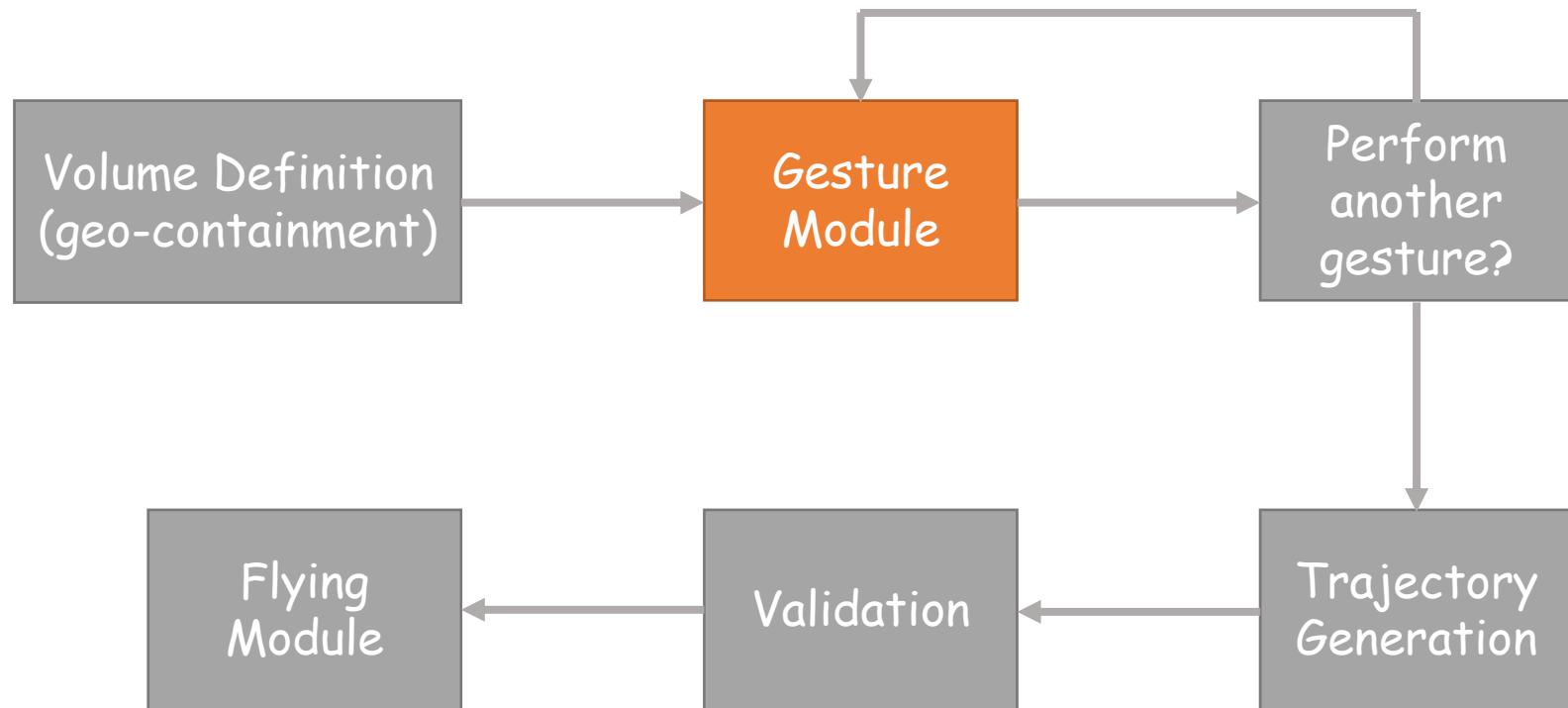
Ground Control System





Volume Definition

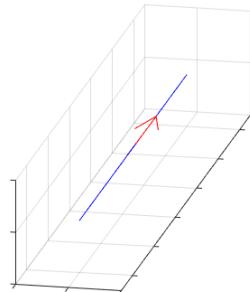




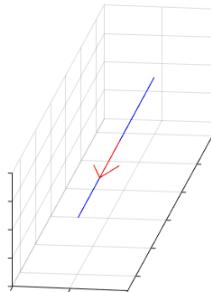
Gesture Library



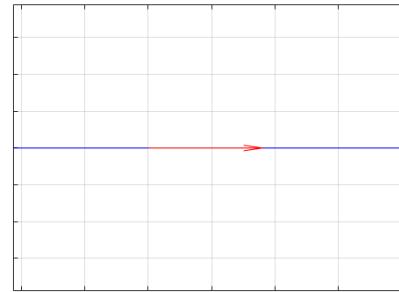
Forward



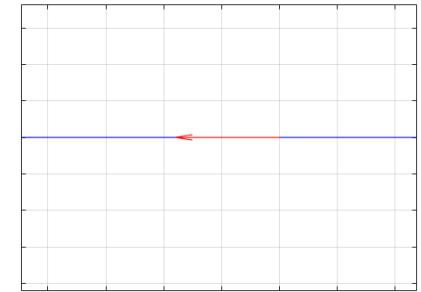
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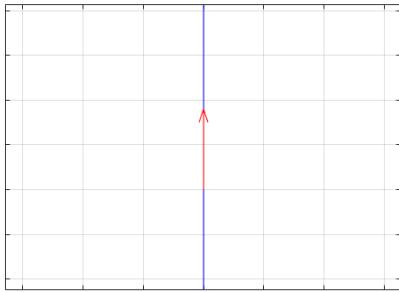
Right



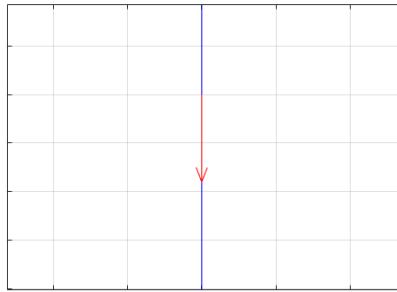
Left



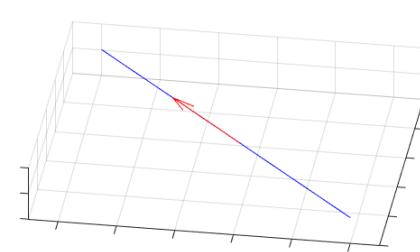
Up



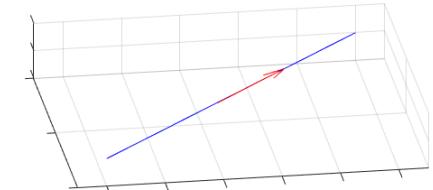
Down



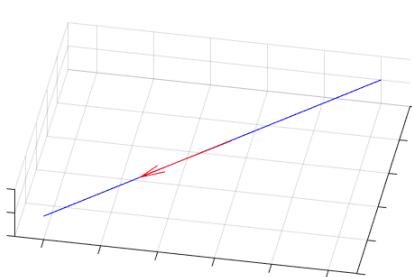
Forward-Left



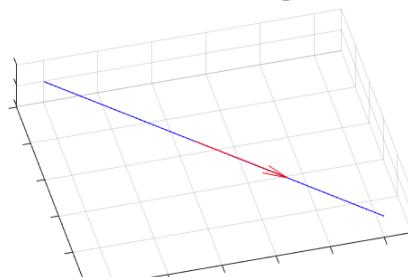
Forward-Right



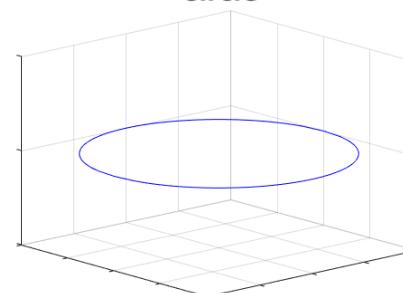
Backward-Left



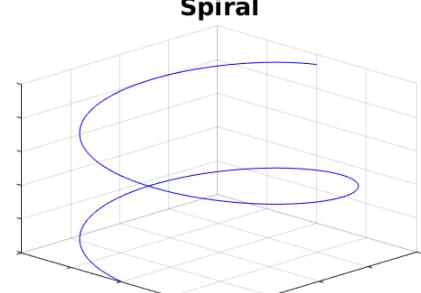
Backward-Right



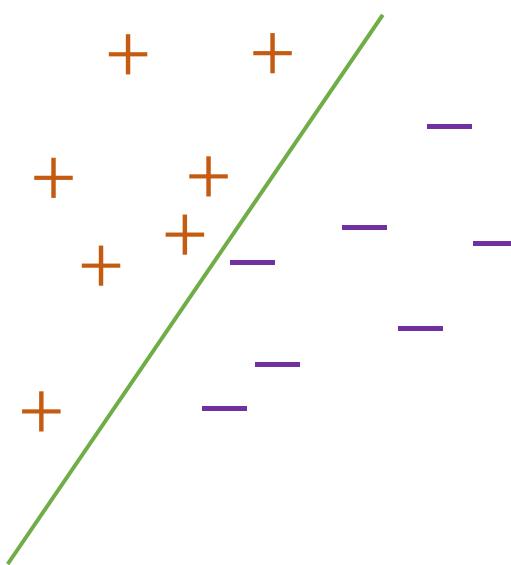
Circle



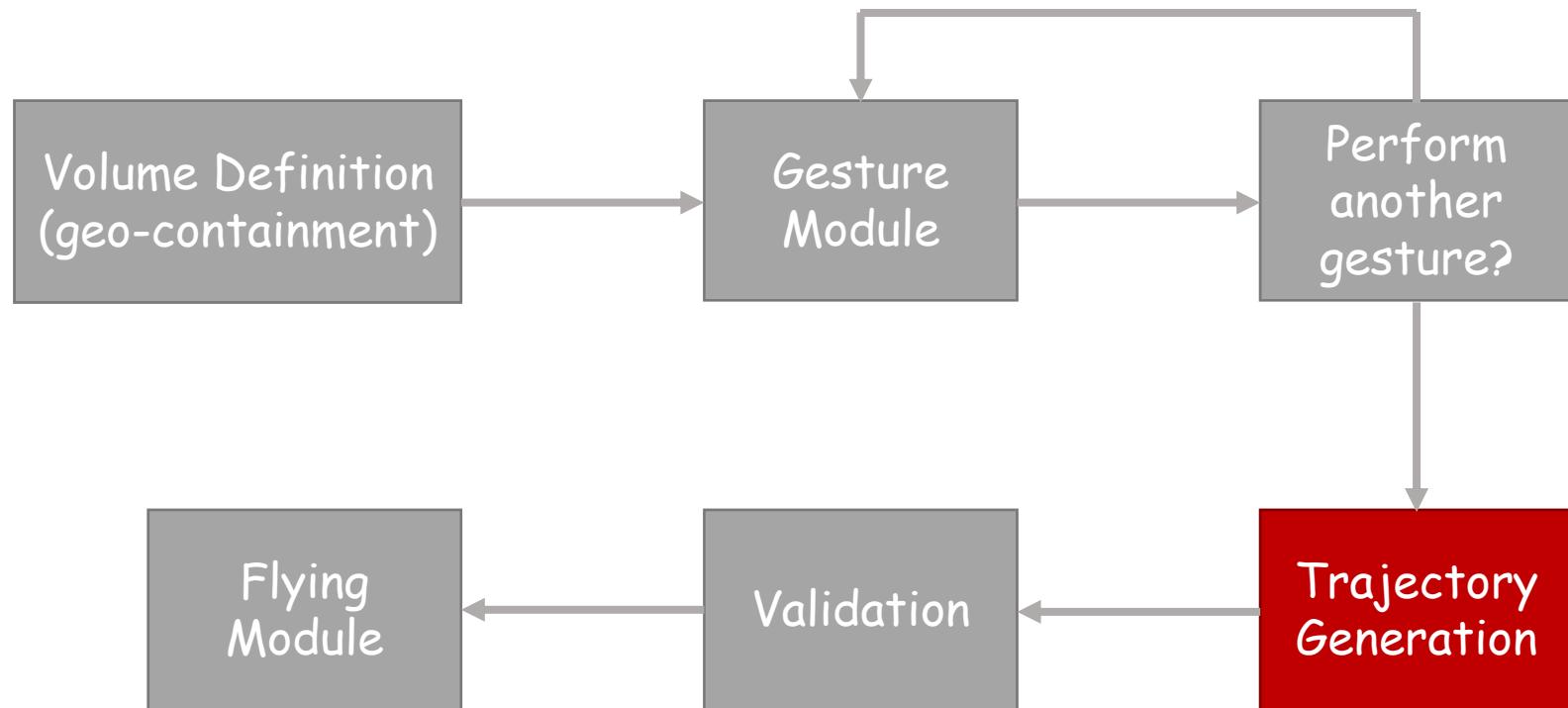
Spiral



3D Gesture Characterization



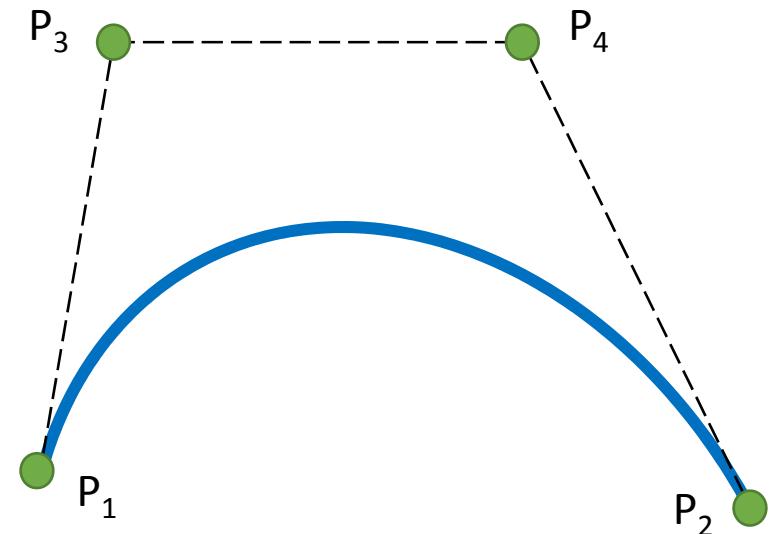
- Linear Support Vector Machine (SVM) Classifier
- 11 Subjects
- 10 samples per gesture
- Features used:
 - Hand movement direction
 - Eigenvalues

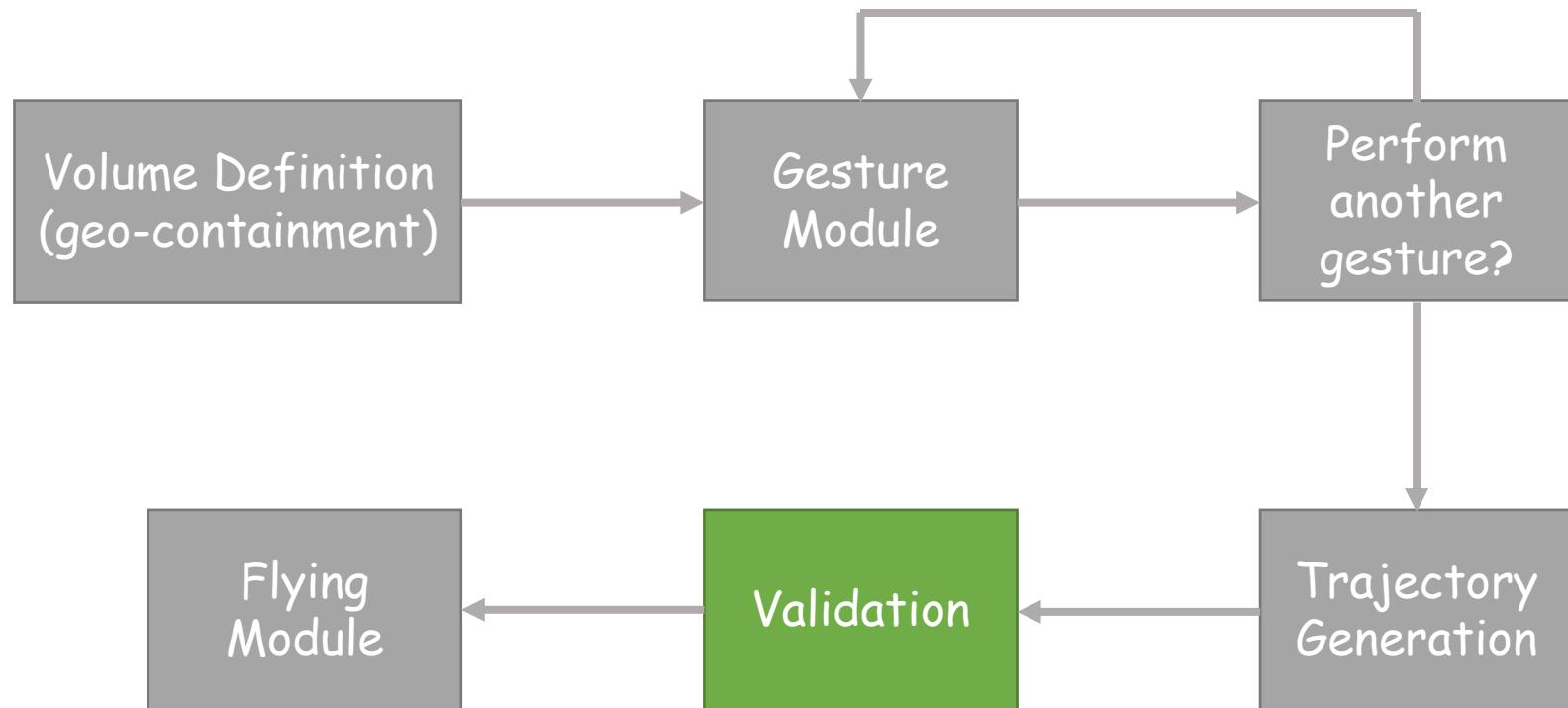


Trajectory Generation

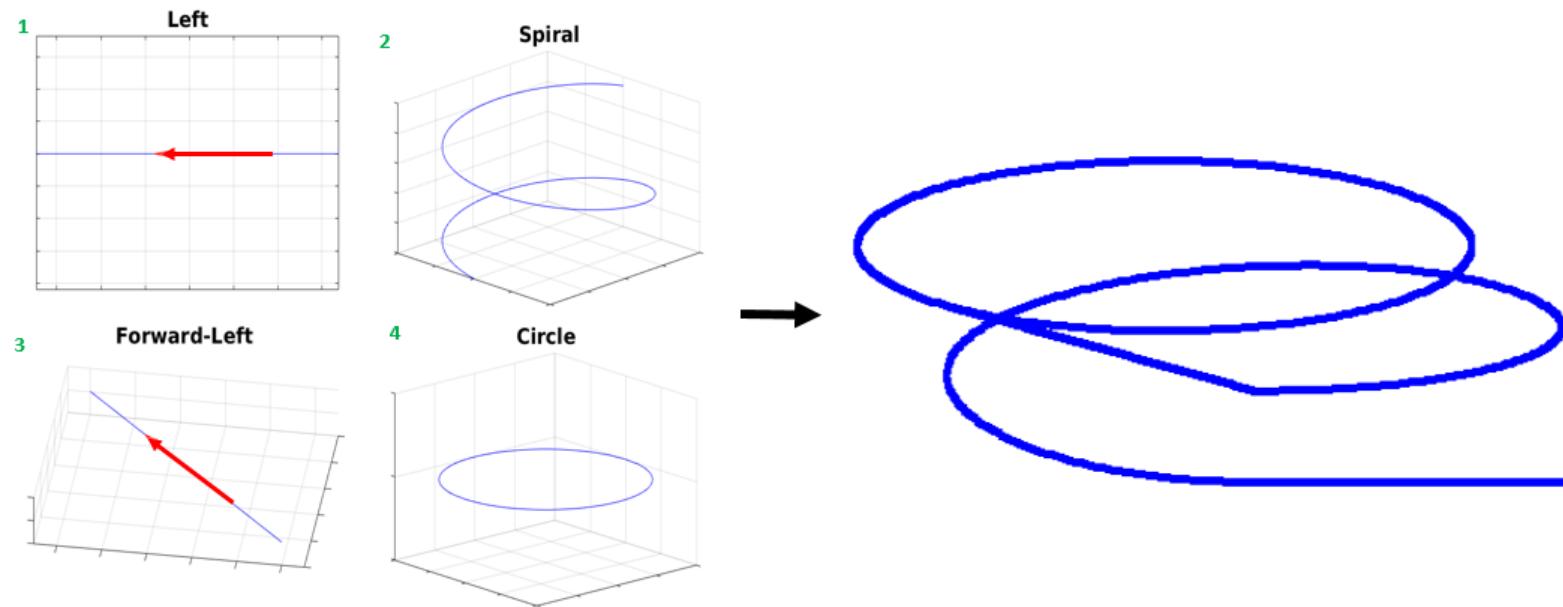
- Translate gesture input segments into sets of Bézier splines
- Combine spline sets into a complete trajectory
- Smoothen spline transitions
- Transmit generated trajectory to vehicle controller

$$B(t) = \sum_{i=0}^n \binom{n}{i} (1-t)^{n-i} t^i P_i$$

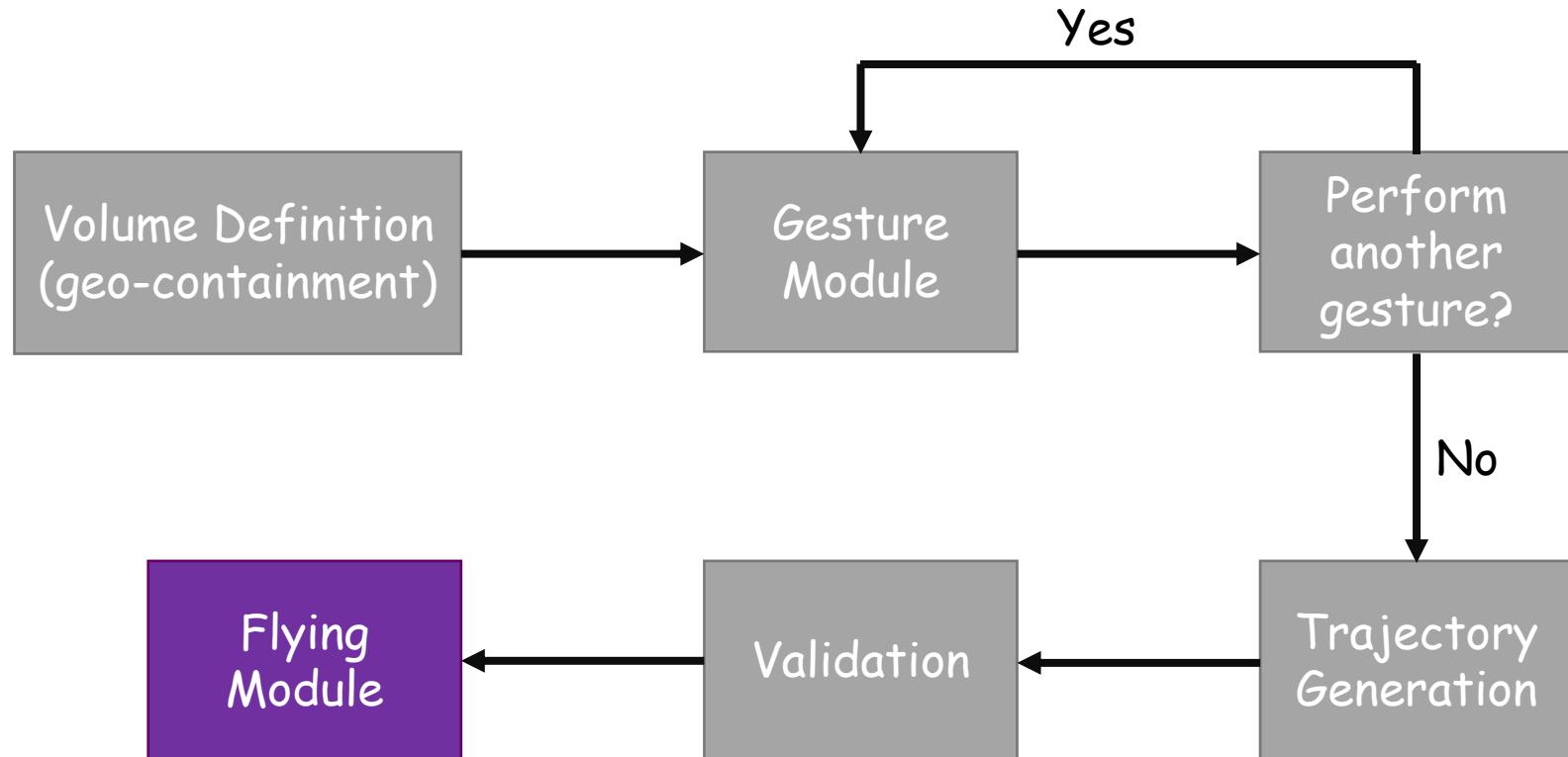




Validation



Sample Generated Trajectory for Validation

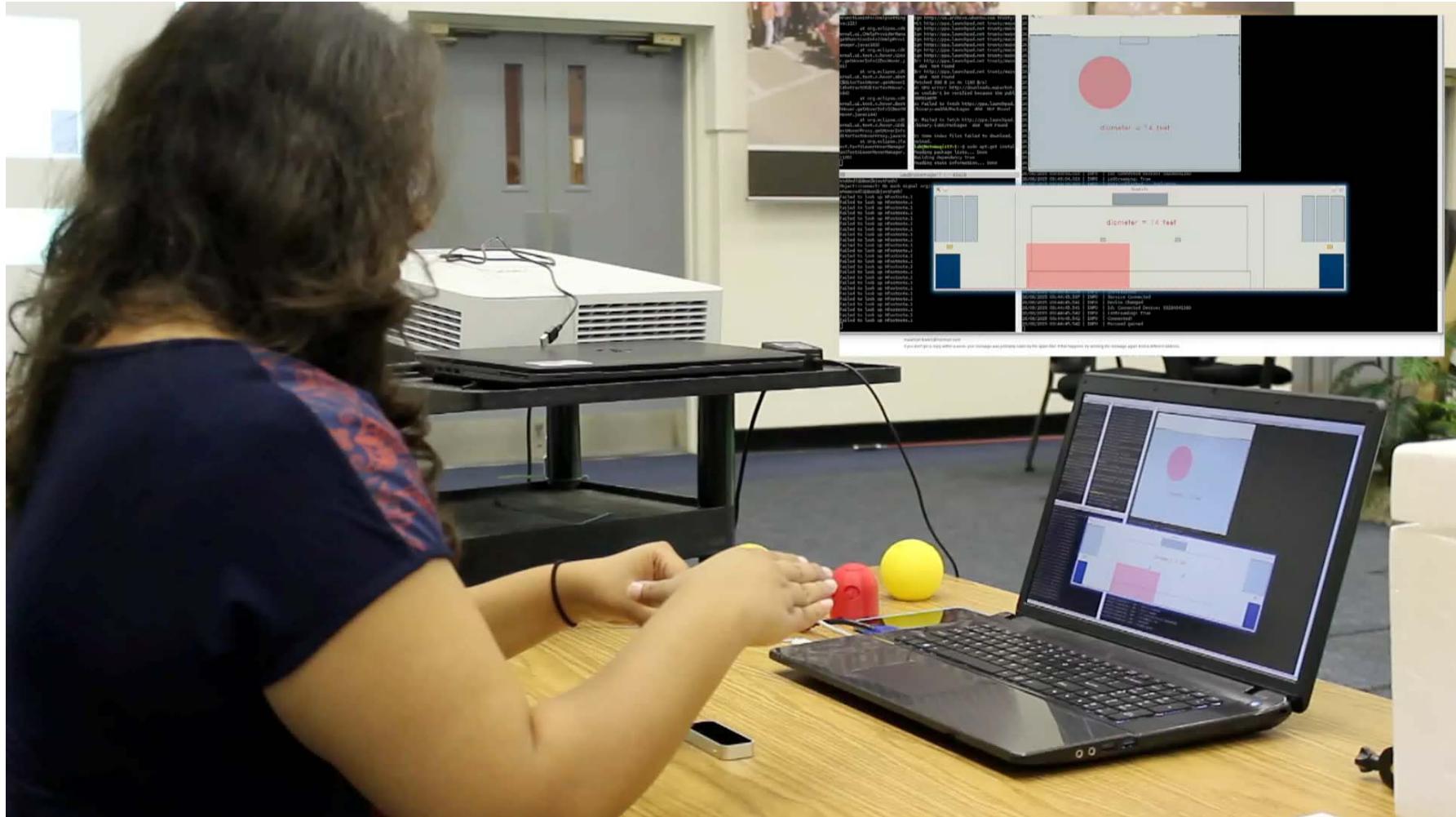


Flight Module



- Operator initiated flight
 - Take off - “Up” gesture
 - Land - “Down” gesture
- Commands sent directly to UAV controller
- Once in the air, the UAV automatically traverses defined flight path
- Hover and waits for land command at end of flight path

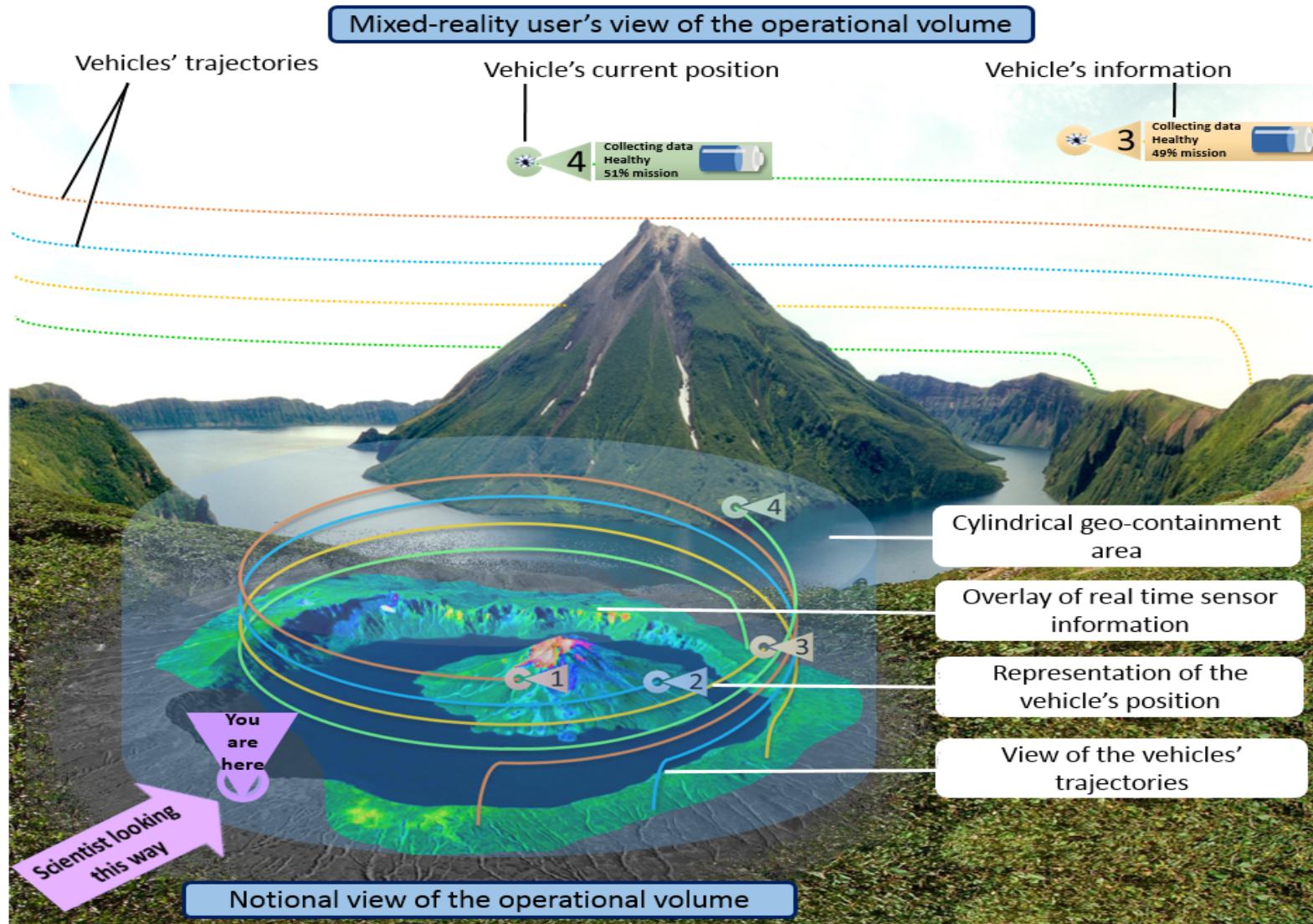
Demo



Sample Flight Path



Potential Future System



Future Work

1. The interface can be extended to include the definition of additional geometric constraints if necessary (e.g., clockwise vs counterclockwise direction on a circle).
2. The gesture library can be extended (e.g., spiral forward).
3. Gesture segmentation: A user may wish to define a complete square shape instead of teaching each segment one-by-one.
4. Extending the system to include real-time mission supervision and trajectory modification.
5. Perform user studies to fully validate the methodology.

Conclusion

- Fully functioning end-to-end Ground Control System for defining trajectories for unmanned vehicles
- Intuitive, natural language interface
- Gesture Library
- Robust gesture characterization
- Feedback mechanisms at every step

User does NOT need to understand low-level system architecture

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AUTONOMY
INCUBATOR